Main agronomic results of RAS on-farm experimentation network in West Sumatra

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Introduction

West Sumatra is a relatively rich and diversified province with both fertile landscapes in the highlands, and very poor, degraded and hilly areas, as in the northern tip of the province in the sub-district of East Pasaman (see Map 1). Traditionally, in East-Pasaman, local Minang farmers have old jungle rubber gardens close to rivers. The hills are burned every year, and are covered with *Imperata cylindrica*. The farmers have very little "sawah" (irrigated rice fields), and still rely in part on shifting cultivation and rubber.

After a discussion with staff of Pro-RLK*, a local GTZ development project, it became obvious that RAS systems might be a potential solution for these farmers. Preliminary discussions and a rapid survey enabled us to select the villages of Bangkok and Lubuk Gadang. However due to limited funds for logistics and monitoring, it was impossible to implement the full project in Lubuk Gadang. Nevertheless, we did provide clonal planting material and information on RAS cropping patterns to the farmers there.

The output of the preliminary discussions with farmers led us to select the RAS 2.2 trial for this area. This was suitable, as farmers have very limited capital, little land for their upland rice, and very limited family labour. There is virtually no opportunity cost for labour, as they do not have access to off-farm work in plantations, as is the case in the other province where the SRAP has been implemented.

Soils are heavily leached, with low nutrient availability. The land is steeply sloping, and prone to erosion. The climate is equatorial with one main rainy season from October to March. The total annual rainfall is around 2 000 mm, but its distribution may be very erratic. The average altitude of the selected small watershed in Bangkok is 500 meters. All these factors lead to a situation which is very marginal in terms of suitability for rubber systems.

Agroforestry practices, including a combination of intercrops and other perennial trees, and soil conservation measures were essential to preserve the sustainability of rubber based cropping systems in this area. It was also important to optimize

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* We would like to thank here Mr Thomas Fairhurst and Ms Hellen Kramer, from GTZ, who supported right from the beginning the implementation of RAS in this area. Pro-RLK is a project aimed for rehabilitation of critical land.

the labour investment in the relatively small plots. The RAS 2.2 trial, which included upland rice and groundnut intercrops (with a few palawija/secondary crops) was chosen by farmers as this fitted their own strategy. RAS 2.2 protocols (Penot, 1995) can be found in Annex 1.

RAS 2.2 systems in West Sumatra

Three trials, based on the RAS 2.2 framework have been set up in order to find answers to 3 main questions: What type of fertilization? What type of planting material? And what type of intercrop?

RAS 2.2a

This is a trial which aims to identify the most effective fertilization regime for the local conditions. Three levels are being tried: no fertilization, 1 ton rock phosphate/ha at planting time[1] and complete NPK fertilization as recommended by TCSDP. This gives 3 plots per replications (each farm is considered to be one replication). The experiment is being conducted on 4 farms. Rubber fertilization is the only treatment. All plots are intercropped with rice and/or palawijas, with a moderate level of fertilization (the BPS regime, as it is recommended by B.P. Sembawa, the Rubber Research Institute of Sembawa).

RAS 2.2b

This trial is similar to that implemented in West Kalimantan, where the treatments concern the intercrop, upland rice. The first treatment is rice variety; local vs improved high yielding varieties. The second treatment is rice fertilization level (no fertilizer, compared with the CRIFC[2] recommendation (Center for Research on Food Crops, Bogor). This trial has four plots and four replications (farms).

RAS 2.2c

This trial compares rubber clones (PB 260) with 'clonal seedlings (probably GT1 seedlings but sold as BLIG planting material by a South Sumatra project), and polyclonal seedlings (BLIG). BLIG (Bah Lias Isolated Garden) seedlings are produced by the London Sumatra Estate, which is the sole supplier of this planting material. The Pro-RLK project, working with DISBUN[3], has distributed BLIG planting material to local farmers for nurseries and plantations. This trial aims to identify the planting material which is best adapted to local conditions. Each replication has 3 plots, and there are 2 replications (farms).

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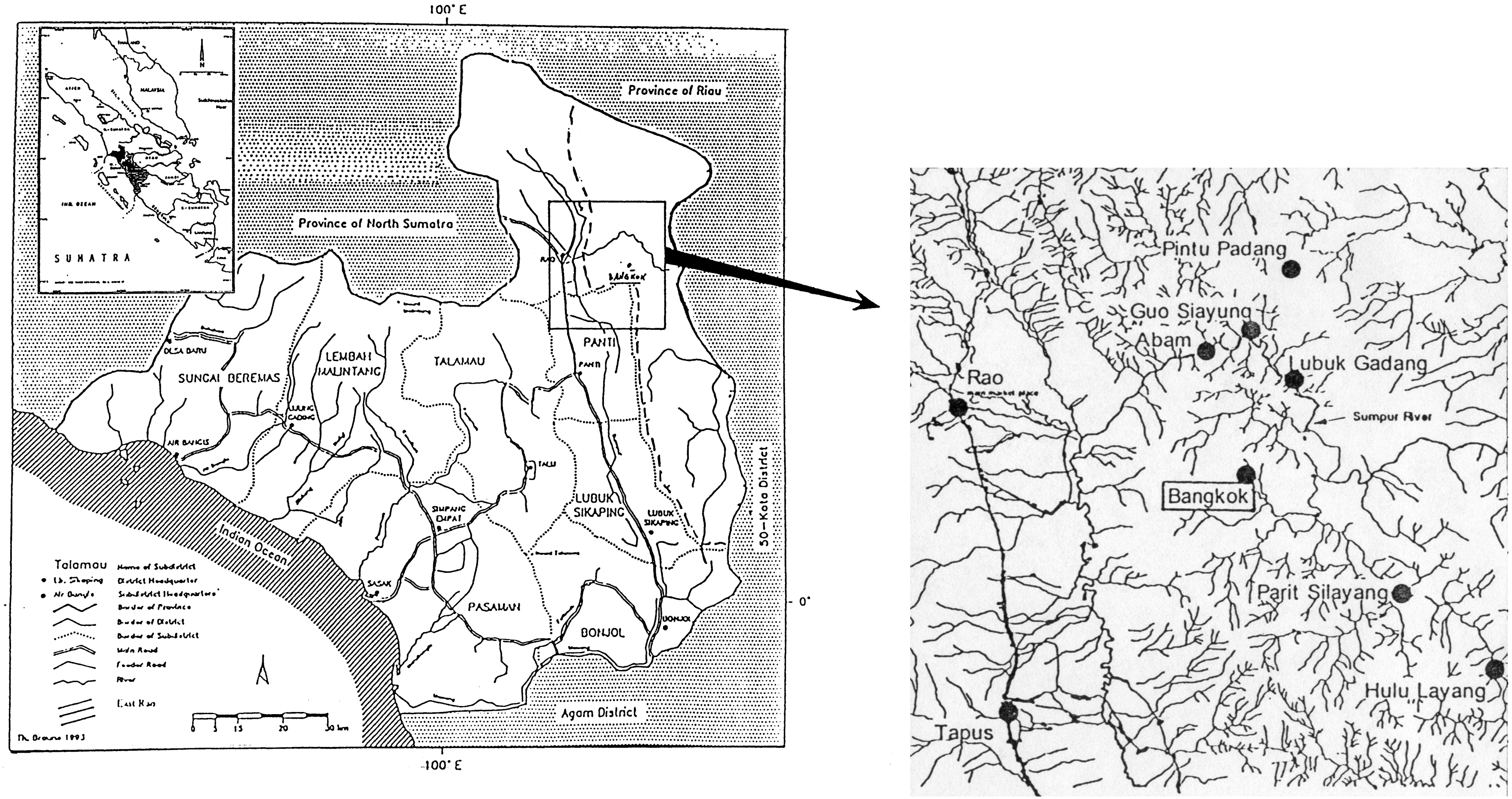
[1] According to recommendations from Thomas Fairhurst, PPI (Potash and Phosphate Institute/Singapore, Pers Comm.)

[2] CRIFC is the Center for Research in Food Crops, Bogor.

[3] DISBUN or Dinas Perkebunan or Extension service for estate crops.

Figure 1. Project Site in West Sumatra



Rubber clones vs BLIG for East Pasaman area: which type of improved planting material?

Improved rubber planting material may be divided in two main groups, selected seedlings and clones. Table 1 displays the characteristics of each type of planting material. To summarize, clones have the highest production potential and some very good secondary characteristics (such as resistance to diseases). On the other hand, they are more expensive, require more weeding and attention, good technical skills, and a framework of budwood gardens and nurseries to supply farmers with budded stumps.

Seedlings have the reputation of being more adapted to agroforestry conditions (at least for jungle rubber), with good growth, ease of planting using seeds, and a low to medium cost according to the type of seedling. However, seedlings are genetically very heterogeneous, leading to poor tapping management, and yields are low to medium. The current results from Rubber Agroforestry Systems research in Jambi and West Kalimantan suggest that in similar agroforestry conditions, selected clones grow as well as seedlings when clonal stumps in polybags are used.

In the following paragraphs the characteristics of 3 different types of planting material: unselected seedlings, polyclonal seedlings and clones are presented. A summary of these characteristics is presented in Table 2.

Unselected seedlings

The main characteristic of unselected seedlings is the high heterogeneity of trees in terms of production and disease resistance, which is common to all seedlings when compared with clones. Extensive surveys in the 1930's (Djikman) showed that 70 % of the production is given by only 30 % of the trees. Tapping labour and other potential costs (fertilization, weeding) are far less cost effective for this other 70 % of the trees. Heterogeneity in growth, production and susceptibility to diseases is a main features of all non-clonal planting material. Table 1 shows the expected variability of various types of planting material.

***Table 1.* Evolution of different types of rubber planting material; their performance and cost of establishment per hectare**

Year of availability and planting at commercial scale	Yield Kg ha^{-1} $year^{-1}$	Remarks
1910	325	Unselected seedlings
1920	450	Selected seedlings (thinning)
1926	725/775	Mother tree seedlings and better cultural practices
1930	1,350-1,400	First generation of clonesTJIR 1 type
1950-60	1,500-1,700	Second generation of clones (PR 107 type)
1980	1,700-2,000	Third generation of clones (PB 260 type)

Source: (Djikman 1951), (Penot and Aswar 1994)

***Table2.* Main characteristics of different types of rubber planting material**

Planting material	Advantages	Disadvantages
Unselected seedlings USS	Good growth, low cost. Relatively good adaptability to local conditions. Good availability.	Very low productivity: 350 to 500 kg/ha. Heterogeneity in production and resistance to diseases (seedling population).
Mother tree seedlings MTS	Good growth. Medium cost (selection). Relatively good adaptability to local conditions. No longer available.	Medium to high productivity (according to level of selection): 700 to 1500 kg/ha. Heterogeneity (seedling population).
Clonal seedlings ICS	Good growth, low cost. Relatively good adaptability to local conditions. Good availability for ICS from current clones.	Low productivity: 500 to 700 kg/ha. Heterogeneity (seedling population).
Polyclonal seedlings PCS	Good growth. Medium cost (BLIG), (according to level of thinning). Relatively good adaptability to local conditions.	Medium productivity: 1000 to 1500 kg/ha. No specific leaf disease resistance. Heterogeneity. Low availability (from PT LONSUM only). Requires high level of thinning. As expensive as clones if well thinned (high selection).

Planting material	Advantages	Disadvantages
Clones (various types of clone)	Slow to very good growth. Medium to high productivity: 1500-2000 kg/ha. Homogeneity. Resistance or susceptibility to various diseases (depending on clone). Labour saving for tapping. Possible sale of rubber wood as valuable timber.	Requires grafting. Clonal purity must be maintained. Requires a minimum level of weeding. Necessary to select clones suited to the local environment. More susceptible to diseases if monoclonal plantation (more risks in small size plantations). Expensive if not produced by smallholders themselves.

Clonal seedlings

These seedlings are obtained through the collection of seeds from existing clonal plantations. Dijkman (1951) estimated that by the 1950's, most of the farmers in North Sumatra were in fact using clonal seedlings collected from estates. This was because many of the estate workers established their own plantations in the surrounding areas. This is probably true for that particular province but not for other provinces where estates, and therefore sources of clonal seedlings were scarce. Farmers in the other provinces thus had to rely on seeds collected from existing jungle rubber gardens. However, it is clear that after a century of rubber seed dissemination all over Sumatra and Kalimantan, the current population of local seedlings is partly based on clonal seeds.

We have no clear data on the performance of clonal seedlings planted by smallholders, except for the SRDP project. The only indication is that yields of smallholders is higher in North Sumatra than in the other provinces as suggested by DGE statistics (DGE 1996). However, many farmers have also established a lot of clonal plantations in that province, so from current statistics it is not possible to distinguish yields of clonal seedling plantations, from jungle rubber or from clonal plantations.

Studies have been conducted to compare the performance of certain clones and the clonal seedlings derived from these. One has to keep in mind that all these trials and comparison made in the 1930's and 40's were based on the first or second generation of clones. These generally have relatively poor yields (around 1 000 to 1 500 kg/ha/year) as shown in Table 3 (average figures for Malaysia in the 1930's).

Table 3: Yield comparison between clones and seedlings in Malaysia in inland estates trials (mean yield over 5 years)

Type of improved planting material (Tapping system d/2)	Inland Estates	Coastal Estates
Clones	1414	1220
Clonal seedlings	1132	954
In % of clones	80%	78%

Source: (Burkill 1952)

A study was conducted on GT1 clonal seedlings (1315 trees), at the IRRI station of Sembawa in South Sumatra in the 1980 s (Delabarre, 1987). The heterogeneity of production of this planting material (‘GT1 ill.) is high as for all seedling populations. 20 % of the trees gave 44 % of total production. The average yield was 1183 kg/ha for a D/2 tapping frequency (150 tappings/year, similar to farmers practices). Such a high tapping frequency increases the risk of brown bast disease on the tapping panel, leading to a serious decrease in production of the highest yielding trees (up to 20 % of the trees). This is equivalent to a loss of 25 % of the potential yield without brown bast, estimated at 1577 kg/ha). Such yields have been obtained with rigorous thinning and selection of seedlings at planting time. We should acknowledge that in reality, farmers never practice such selection and usually plant every available seedling into the field. Therefore, it is an illusion to expect such high yields from clonal seedlings in smallholder conditions. The same conclusion can be drawn with polyclonal seedlings.

Polyclonal seedlings

Polyclonal seedlings are obtained by collecting seeds from isolated gardens planted with a selection of clones. North Sumatra estates used to plant this type of planting material until the 1960's (in particular "PBIG" from the Prang Besar Estate in Malaysia). During the same period, farmers never had access to such planting material. The first series of polyclonal seedlings show low yields (maximum of 800 kg/ha/year) compared to first generation clones such as TJIR 1, and yields far below third generation clones such as PB 260. The average yield of BLIG compared to other clones is shown in Figure 2 and Table 4.

The current existing source of polyclonal seedlings in Indonesia

The only current source of polyclonal seedlings, BLIG (Bah Lias Isolated Garden), is located in North Sumatra at London Sumatra Estate. This estate is still advocating the use of BLIG, however this company itself is no longer planting BLIG for latex production, but for rubber wood production. Ease of planting, and low cost (assuming no selection, and that one seed produces one satisfactory plant) are cited as being the main advantages of BLIG. BLIG is the only real polyclonal seedling type available in Indonesia. This monopoly situation is therefore very dangerous for suppliers, and the supply itself is very limited indeed, as the area of BLIG gardens is only 5 hectares. In reality, good yields can be obtained only with a rigorous thinning in both the nursery and the fields, which leads to the use of more seeds than the required number of trees in the field. In that case, BLIG is a planting material that is as expensive (if not more), than clones. Yields of BLIG or PBIG recorded in estates (PT LONDON SUMATRA) result from a very severe thinning regime, which is never likely to be the case with smallholders.

Figure 2. Comparison of yields of BLIG with a clone (RRIM 600)

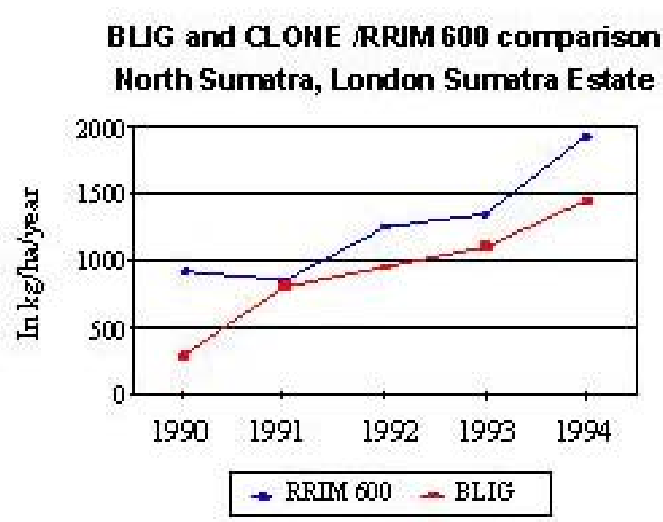


Table 4 Production of BLIG compared to clones at PT London Sumatra (North Sumatra)

Location	Year of planting		Number of trees		production in kg ha^{-1} $year^{-1}$					Cumulative production	in % of clone
	planting	material	Total	producing	1990	1991	1992	1993	1994		
Sei Rumbia (N. Sum)	1984	BLIG	356	354	244	865	1142	1187	831		
Palang Isang (S.Sul)	1985	RRIM 600	381	363	921	852	249	1349	1928	6299	
	1986	BLIG	391	391	286	810	952	1105	1445	4598	73%
	1987	BLIG	401	393		241	666	932	1249		65 %
	1987	GT1	402	389			594	1309	1957		
	1988	BLIG	409	390				465	1001		
	1989	BLIG	419	408				421	774		
	1990	BLIG	436	348					331		

*) Data from Palang Isang estate

**) Data obtained in December 1994

Source: Pusat Penelitian Karet, IRRI, 1995

Clones

Clones are produced by grafting a bud from a clonal tree onto a well developed rootstock, ('budding). The first budding was carried out in North Sumatra in 1916. In 1936, as many as 175 000 ha in Sumatra were planted with these first generation clones. Budding does not totally suppress the genotypic variability, but seriously reduces it (normally to less than 25 %). Using homogeneous clones increases the cost effectiveness of any input investment, as all trees will profit from it. However budding does not transfer the full performance of the mother tree. That is the reason why it is necessary to test new clones for at least 15 years to confirm their performance and stability. The comparisons between clones and improved seedlings, up until the 1940s', were based on these first generation clones. These clones were not as high yielding as clones now, and generally had quite poor secondary characteristics.

The first properly tested clones began to be available in 1934, in North Sumatra and West Java. The current clones, of the third generation, perform excellently, both in estates and in smallholding according to the type of clone. Most of them have the following characteristics: precocity (PB 260 is tapped at 3.5 years of age at the Goodyear estate, in perfect conditions, but most of them can be opened at 5 years old), and very good vigour and growth (PB 260 and RRIC 100). They are also high yielding: 1800- 2000 kg/ha for PB 260 and 1700 kg for GT 1 in smallholdings in South-Sumatra, (Penot, 1993); and also have good resistance to leaf diseases.

The homogeneity of clones enables good tapping and good bark renewal, assuring a long production potential. Eventually, the frequency of tapping can be reduced to D/3[4] without any production loss (and without use of stimulation) for clones like PB 260 and RRIC 100. This leads to significant savings in labour (33 % in the case of D/3). The use of stimulant can even reduce the tapping frequency to D/4, if high labour costs necessitate this. Using clones gives the farmers room for further improvement in labour productivity, as well as a better final income from the rubber wood sales at the end of the plantation. This is not the case with seedlings, due to their conical shaped trunk; the wood can only be sold as firewood at a much lower price. One hectare of clonal trees may produce an average of 200 m^3 of wood for timber or pulp.

Productivity versus cost: improved planting material adoption

This trade-off is quite clear: adoption of clonal rubber means high productivity, but also a higher cost of investment in terms of inputs and labour than jungle rubber, whether planted either in monoculture or in RAS systems.

The cost of clones produced by farmers, or purchased as budded stumps from private nurseries (210 to 270 000 Rp), and that of BLIG (324 000 Rp assuming a medium level of selection) is within the same range. On the other hand, in the case of polybagged clones supplied by a local private nursery (market price), the cost of clones is twice that of BLIG. However, clones have major advantages. The cost can be lower than that of BLIG (if BLIG is selected in the nursery, and clones are produced by farmers themselves), the supply of clones is better in most locations, and adaptation to local conditions is better. Clones also have the advantage of better productivity, homogeneity of production, labour saving during tapping and better leaf disease resistance (if the clone is well selected to local

[4] D/3 means a tapping frequency based on 3 days.

environment). However, clones require more weeding, and therefore more labour during immature period.

Table 5: Cost of IGPM in a new plantation

IGPM	Cost per unit in rupiah	Number of plants for 1 ha of plantation	Total cost of IGPM for 1 ha in rupiah
Unselected seedlings (seeds) Jungle rubber	0	1000	0
Clonal seedlings 4 seeds per planted tree	12.5	600 x 4 seeds	30 000
PCS (BLIG) 3 seeds for 1 planted tree no selection (transportation cost not included)	90	600 x 3 seeds	162 000
PCS (BLIG) 6 seeds per planted tree Medium level of thinning (transportation cost not included)	90	600 X 6 seeds	324 000
Clone (budded stump produced by the farmers) 4 GT1 seeds = 50 Rp Grafting = 100 Rp budwood = 100 Rp Miscellaneous = 100 Rp	350 in polybag	600	210,000
Clone (stump bought at private nursery and put into polybag) 350 Rp/stump + 100 Rp/Polybag	450 in polybag	600	270,000
Clone (produced by private nurseries, in polybag)	1000 in polybag	600	600,000

Number of rubber trees required for 1 ha = 550 + 10 % for replacement = 600.

Budded stumps can be purchased by farmers and planted in polybags in their own small nurseries without any technical problems. But the farmer has still to rely on clonal purity, which is guaranteed only by the private operator, without any control or official certification. This may lead to problems, as farmers do not have any control over quality. The cost effectiveness is very low if the farmer is paying a high price for planting material which is no better than unselected seedlings. Budded stumps do not necessarily mean they are clones (as sometimes stumps are budded with non clonal budwood). Therefore a system is needed whereby clonal purity can be guaranteed to farmers.

The level of production of BLIG will mainly depend on the level of selection through thinning. Generally, farmers will try to plant most of the seedlings produced from purchased seeds, and in practice we may expect to have a very low level of thinning, leading to a lower production (probably around 1 000 kg/ha or less). In that case, of course the cost of seeds is lower (3 seeds per tree planted only). A better production might be expected, at least for the first 4 years (but there is not sufficient information available for the period after that) with a medium level of thinning (estimated with a minimum 6 seeds per planted tree). The supply of BLIG is problematic; there are only two sources in North and South Sumatra. Transportation and seed viability (only 3 weeks after harvest) are very serious limitations.

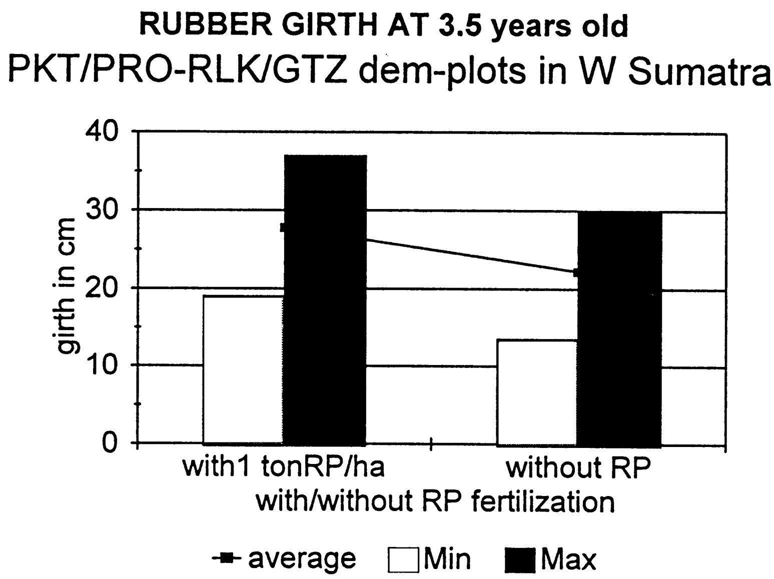
So far, farmers' decisions about the type of planting material they use is highly dependent on income. According to a survey in South Sumatra (Gouyon 1995), 45 % of the farmers still use unselected seedlings, 22 % use GT1 seedlings for jungle rubber planting and 32 % use clones (60 % if income was above 5 million Rp/year in 1990). It is also dependent on access to planting material and presence of estates, rubber projects or private nurseries. In South-Sumatra in remote villages (still considered as pioneer zones), the percentage of farmers using clones is only 1.5 %. In villages close to estates or PTP (government estates), or private nurseries, the rate is 32 % (A Gouyon, 1995).

P fertilization for rubber

The first 2 years are critical in terms of rubber growth in conditions such as those in East Pasaman. It is therefore necessary to determine the best combination of labour and input levels for this period of time. Fertilization seems to be the best choice of input that will overcome poor soil fertility and boost rubber growth, and that is also optimal in terms of cash and labour availability. Among the key nutrients, it seems that P is the main limiting factor in these soils.

A PKT/ProRLK/GTZ demonstration plot established in West-Sumatra in 1993 shows evidence of a significant effect on rubber growth of 1 ton of rock phosphate/ha applied at planting time (see Figure 3, source: Penot, Fairhurst *et al.* 1996).

Figure 3. Rubber growth with and without rock phosphate



Immature rubber period in rubber based cropping systems: a window for food cropping

The secondary effect of intercrop fertilization on rubber growth has previously been demonstrated. Experiments are being conducted in order to identify the most suitable rice varieties (local and improved) and the most economic fertilization levels. In West-Kalimantan the rice varieties were 'Way Rarem and 'Jatiluhur (High Yielding Varieties, HYV) and 'Saim from Sembawa/South Sumatra, (local variety). These were planted with two levels of fertilization; no fertilisation, and the CRIFC recommendation (150 kg urea, 250 kg of SP-36, and 100 kg of KCl per ha).

Preliminary results indicate that production of rice and palawija intercrops during the first 3 or 4 years, may be maintained only with sufficient crop fertilization. Risk of crop failure due to blast (fungus), and insect damage is relatively high. Without crop protection, rice yields are still low and may not recoup the cost of fertilization. It also seems that on poor soils such as the leached yellow/red ferralitic soils in West-Kalimantan and West-Sumatra, the establishment of covercrops (in RAS 3) without P addition is not possible (current dose is 500 kg RP/ha). This may explain the farmers reluctance to use nitrogen fixing covercrops. Fertilization at economically viable levels, such as those recommended by TCSDP for the first 3 years[5] only, or the supply of a high amount of P at planting time may be sufficient to enable rubber to grow satisfactorily in such competitive agroforestry environments.

The establishment of rubber based agroforestry systems which are appropriate for local financial, labour, and environmental conditions must include the use of improved planting material[6], and, at a minimum, Phosphorus fertilization.

A participatory approach is a key tool in ensuring the adoption of innovations by farmers, and is part of the SRAP methodology. Feedback from farmers is used in implementation of the research programme, and an understanding of the process of innovation adoption has also been elicited. This is necessary to ensure high adoption levels of the rubber systems currently being tested.

Main Outputs

One of the main features of RAS implementation in East Pasaman, in a relatively remote and marginal area, is that right from the beginning, local farmers have followed the system protocols, which were defined together by scientists and farmers. The farmers have managed their rubber gardens particularly well. All the 8 plots are located in a small watershed that was previously covered by *Imperata* grass.

Initial planting was done in January 1996, in the middle of the rainy season. As rainfall is erratic in this area, 3 weeks of drought after planting led to a high per-

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[5] TCSDP = Tree Crop Smallholder Development Project recommendations are : 200 grams RP/tree planting time and 50 grams urea, 40 grams SP 36 and 40 grams KCl per tree every 3 months.

[6] Rubber clones have been selected for good growth, high yields and resistance to leaf diseases as well as farmers tapping methods. These clones are PB 260, RRIC 100, BPM 1 and RRIM 600.

centage of stump mortality. Thus the "normal" replacement level (10 %) was obviously not sufficient. A second planting was done in September/October 1996 to replace the missing plants.

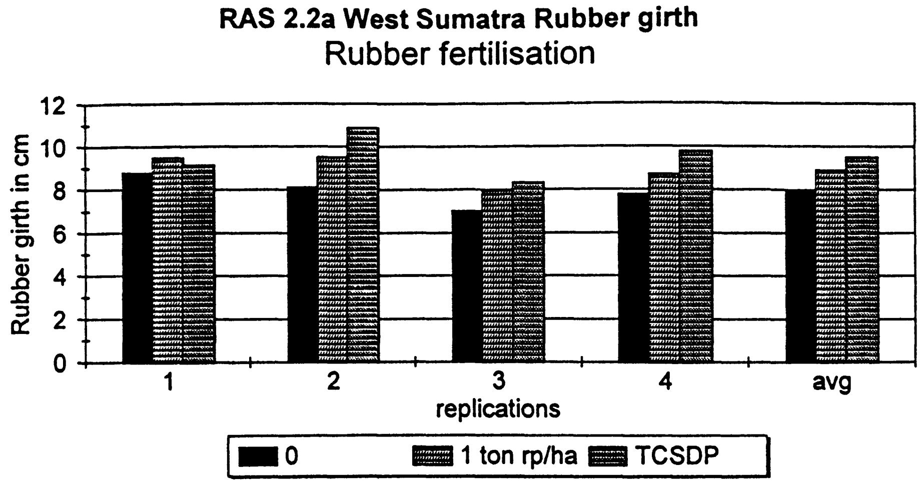
Rice cropping in 1995/96 with local varieties was not successful, nor was the 1996/1997 local rice crop. Eventually, the farmers decided to try a more promising South Sumatra local variety ("Saim", suggested by G Wibawa from BPS/Sembawa), and a High Yielding Variety (HYV) 'Jatiluhur. As a result of this, in 1997, rice cropping was successful. Farmers weeded their upland rice crop very well, which led to very good weed management for both, rubber and the associated trees. Contrary to other zones (especially in West Kalimantan), very few associated trees died. Due to the steep slopes, all plots were planted with protective contour lines of *Flemingia congesta* in order to limit erosion during the rubber immature period.

It should also be mentioned that local farmers are familiar with both BLIG and clonal planting material, as Pro-RLK/DISBUN and PKT/DISBUN respectively provided these through previous small scale projects. The fact that farmers do know the pros and cons of clonal rubber and seedlings (as used in jungle rubber) is clearly an advantage for the adoption of RAS systems. The same conclusion can be drawn concerning the anti-erosion contour line systems using *Flemingia,* as Pro-RLK introduced these to the area several years previously. Therefore, local farmers had already had the opportunity to see the potential and efficiency of such planting material and cultural practices, and this led to a rapid adoption and effective implementation of RAS in the field.

RAS 2.2a

There is an effect of fertilization on rubber growth (Figure 4), however this is not statistically significant, at least for the first 22 months. The small effect of fertilization on the poor soils might be explained by the fact that a proportion of the fertilizers may have been lost due to run-off. This could be the result of heavy rainfall on the steep slopes, which occurred before the protective contour line of Flemingia congesta had become properly established. This confirms the fertilization effect observed in the PKT plots (Figure 3).

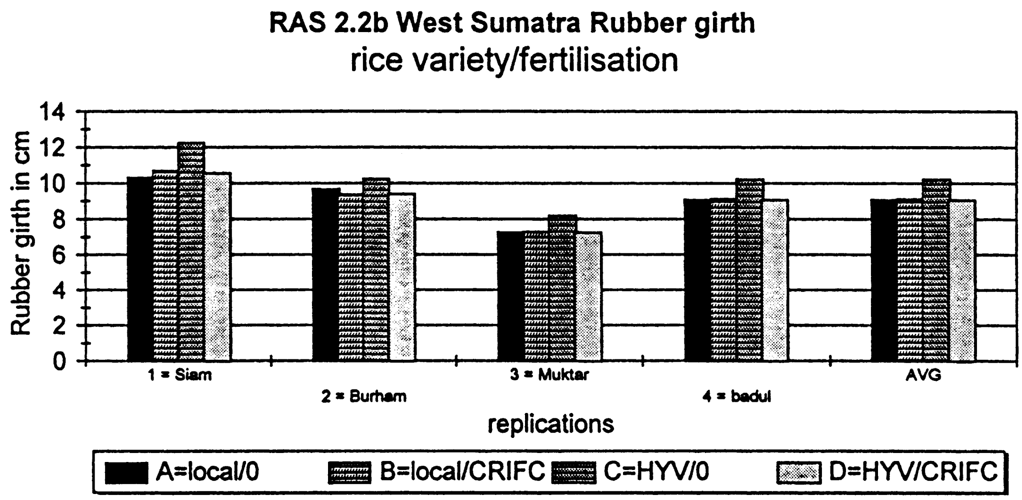
Figure 4. RAS 2.2a: Rubber growth in response to different rubber fertilization regimes.



RAS 2.2 b

There is no clear effect of the combination of rice varieties/fertilization levels on rubber growth, and it seems that the fertilizers applied to the intercrop do not have a significant effect on rubber growth for the first 22 months. The same results were found for a similar type of trials in West Kalimantan (see Paper 2).

Figure 5. RAS 2.2b: Rubber growth in response to intercropping of different rice varieties, in combination with different rice fertilization regimes



RAS 2.2c

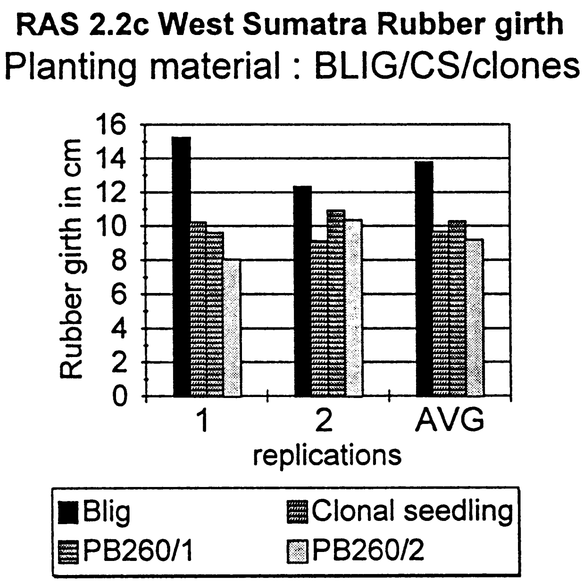
In this trial, it can be clearly observed that BLIG growth is faster than clonal rubber (PB 260) and even clonal seedlings. BLIG has always been acknowledged as a fast growing seedling planting material. London Sumatra Estate is using BLIG as an intercrop (for wood production) between rows of clonal rubber (for latex production). In this case, BLIG is used for its biomass production, rather than for its latex production, on which there is insufficient information over the long term.

In RAS 2.2 with intercrops and good weed management as observed on all plots, this good growth of BLIG is not as much of an advantage as it would have been in the RAS 1 system, where rubber competes with secondary forest regrowth. It is also clear than the use of BLIG in the form of seeds (compared with grafted stumps like clones), is easier to handle by farmers. However, we do not have enough clear evidence that the production potential can be as high as that of clones.

BLIG is also not available on the market any more, as the total production is currently being used by London Sumatra. This very low availability, the situation of monopoly for production of the seeds, and the uncertainty about the future of BLIG leads to recommendations in favour of clones.

In conclusion, the apparent better growth of BLIG (which is expected, as seedlings generally grow faster than clones), may not be considered as a major advantage, but should be noted. Further observations, particularly with respect to resistance to leaf disease (especially *Colletotrichum*),should be continued.

Figure 6. RAS 2.2c: Growth of different types of rubber planting material

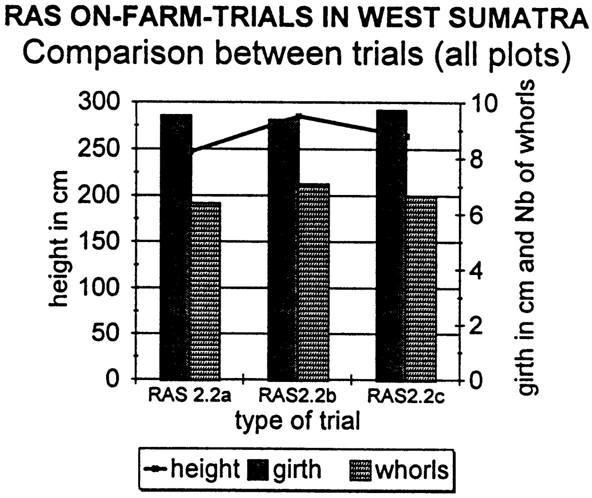


Conclusion

RAS 2 implementation is undoubtedly a real success in East Pasaman, with farmers providing the best possible management on their rubber trial fields.

If we look at Figure 7 which displays rubber growth for all RAS trials using clonal rubber, (excluding the plots with no fertilization or plots using BLIG or clonal seedlings), we see there is very little variation between trials. This demonstrates the similar management of the trials, with respect to intercropping and weeding.

Figure 7. Clonal rubber growth in the 3 trials



There is very good evidence on the potential of adoption of such systems in this area from the example of Lubuk Gadang village. In this village, SRAP supplied a selection of farmers with clones and information on RAS, but no further inputs were provided, due to logistical difficulties. Local extension, through the Pro-RLK/GTZ project, continues to provide only a general technical information service. 22 months after planting, RAS plots are well maintained and are as successful as in Bangkok. This is obviously due to the determination of local farmers to adopt a cropping system which is clearly adapted to the local conditions, in spite of the fact that there has been none of the intensive monitoring that was the case in Bangkok village.

This observation is very promising both for further development and adoption of RAS 2 systems in the area, and for the successful rehabilitation of very degraded lands.

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